Tulane

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May 27, 1996

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Dr. Ralph Wachter
Program Director
Software Research Program, Code 311
Mathematical, Computer and
    Information Science Division
Office of Naval Research
800 North Quincy Street
Arlington, VA   22217–5660

Dear Dr. Wachter:

This is the final project report for the contract No. N00014-95-1-0772 that I was PI on. The contract was for support of the Eleventh Conference on the Mathematical Foundations of Programming Semantics, which took place at Tulane University from March 29 to April 1, 1995. The conference featured invited addresses by six internationally recognized researchers, two special sessions, and twenty-four talks selected from papers submitted by researchers from all over the world. Of additional significance is the fact that the *Proceedings* of the meeting formed the first volume of the new electronic series, *Electronic Notes in Theoretical Computer Science* which is being published under the auspices of Elsevier Science B. V., and which is available on the World Wide Web through their archives.

We wish to express once again our thanks to ONR for providing us with this much-needed support. ONR has a been a continuing supporter of the MFPS series, and we believe has contributed greatly to the success and world-wide recognition it receives.

Best regards,

Michael Mislove
Professor
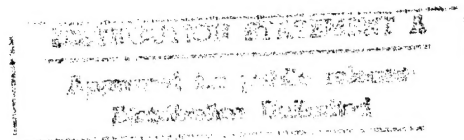
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Report on Conference Support Contract
No. N00014-95-1-0772
Michael Mislove, Principal Investigator
Mathematics Department
Tulane University

Summary of Completed Project

The funding from ONR was used to support the invited speakers at the meeting, to help support participants in the two special sessions held during the meeting, and to underwrite general conference support costs, including support of graduate students, women and members of minority groups to participate in the Eleventh Annual Conference on the Mathematical Foundations of Programming Semantics. This annual series of meetings provides a venue for mathematicians and theoretical computer scientists to meet and discuss problems of mutual interest.

The eleventh meeting took place on the campus of Tulane University, New Orleans, LA from March 29 to April 1, 1995, and featured invited addresses by six international researchers, two special sessions and twenty-four talks selected from papers submitted by researchers from all over the world. The conference attracted 77 participants from 9 countries, and the ONR grant helped provide support for the six invited speakers, for the participants in the special session, and for women and minority participants who participated in the meeting. The conference published its *Proceedings* as the first volume of the new series *Electronic Notes in Theoretical Computer Science*, which is published electronically on the World Wide Web using the facilities and under the auspices of Elsevier Science B. V. This *Proceedings* can be accessed via the URL: http://www.elsevier.nl/locate/entcs/volume1.html. A further *Proceedings* consisting of expanded, journal-length papers selected from the papers presented at the meeting is in preparation. This will appear as a special issue of the journal *Theoretical Computer Science*.

Detailed Information

The *Proceedings* of MFPS 11 appeared as Volume 1 of *Electronic Notes in Theoretical Computer Science*. As indicated above, this can be accessed via the URL:
http://www.elsevier.nl/locate/entcs/volume1.html. A hard copy of this *Proceedings* volume was distributed to participants at the meeting. A second *Proceedings* will appear as special issue of the journal *Theoretical Computer Science*, and is currently in preparation.

This special issue will consist of extended, journal-length papers selected from the papers presented at the meeting, and these papers will be refereed to the usual high standards of *TCS*. The Eleventh Conference on the Mathematical Foundations of Programming Semantics attracted 77 participants from nine countries. The countries include Canada, Italy, France, Germany, Japan, The Netherlands, Scotland, England and the United States. Sixty of the participants were faculty members at various institutions of higher learning or researchers at industrial research labs, and 17 of the participants were graduate students. Of the twenty-four papers selected for presentation at the meeting from the over 40 submissions that were received, seven were authored or co-authored by graduate students.

The invited speakers for the meeting were

Andreas Blass	*(Michigan)*,
Edmund Clarke	*(Carnegie Mellon)*,
Neil Jones	*(DIKU, Denmark)*,
Robin Milner	*(Cambridge)*,
John Reynolds	*(Carnegie Mellon)*, and
Robert Tennent	*(Queens University, Canada)*.

There also were two special sessions. One was organized by Stephen Brookes *(Carnegie Mellon)* and Robert Tennent and focused on work related to the research of John Reynolds. This was in celebration of Professor Reynolds' 60th birthday year. In tribute to Professor Reynolds, the *Proceedings* of the meeting were dedicated in his honor. The second special session was organized by Luca Cardelli *(DEC)* and John Mitchell *(Stanford)* and focused on object-oriented programming languages. In addition to the invited speakers, the participants at the meeting included such distinguished researchers as Cliff Jones *(Manchester)*, Gordon Plotkin *(Edinburgh)* and Dana Scott *(Carnegie Mellon)*. A complete program for the meeting is attached to this report, as is a breakdown of the numbers of participants by country, and a synopsis of those who were supported by the ONR funds.

Mathematical Foundations of Programming Semantics
Eleventh Annual Conference

Tulane University
New Orleans, Louisiana

March 29 - April 1, 1995

Participants: 7 7

    Faculty   60
    Graduate Students   17

Countries Represented: 9

    Canada
    Italy
    France
    Germany
    Japan
    The Netherlands
    Scotland
    United Kingdom
    United States

Mathematical Foundations of Programming Semantics
Eleventh Annual Conference
Tulane University
New Orleans, Louisiana

March 29 - April 1, 1995

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MFPS XI

Eleventh Conference on the Mathematical Foundations of Programming Semantics

Tulane University
New Orleans, LA USA
March 29 – April 1, 1995

Wednesday, March 29, 1995

All meetings take place in the Kendall Cram Room of the University Center, unless otherwise noted.

8:00 – 8:40 *Breakfast rolls and coffee*

8:40 – 8:50 *Welcome*

8:50 – 9:50 Neil D. Jones, DIKU, Invited Lecture:
"Complexity and Computability from a Programming Language Perspective"

9:50 – 10:25 Karen L. Bernstein and Eugene W. Stark, SUNY at Stony Brook
"Operational Semantics of a Focusing Debugger"

10:25 – 10:45 *Break*

10:45 – 11:20 John Maraist, Martin Odersky, University of Karlsruhe,
David N. Turner and Philip Wadler, University of Glasgow
"Call–by–name, Call–by–value, Call–by–need and the Linear Lambda Calculus"

11:20 – 11:55 Gerard Boudol and Cosimo Laneve, INRIA Sophia–Antipolis
"Termination, deadlock and divergence in the lambda–calculus with multiplicities"

11:55 – 12:30 Frank Pfenning and Hao–Chi Wong, Carnegie–Mellon University
"On a Modal Lambda Calculus for S4"

12:30 – 2:00 *Lunch*

2:00 – 3:00 Robert Tennent, Queen's University, Invited Lecture:
"Syntactic Control of Interference Revisited"

3:00 – 3:35 Peter O'Hearn, Syracuse University and Uday Reddy, University of Illinois at Urbana–Champaign
"Objects, Interference and the Yoneda Embedding"

3:35 – 3:55 *Break*

3:55 – 4:30 Cliff Jones, University of Manchester,
"Granularity and the Development of Concurrent Programs"

4:30 – 5:05 John Power and Makoto Takeyama, University of Edinburgh,
"Bireflective passivity"

5:05 – 5:40 Edmund Robinson, Sussex University,
"Logical Relations and the Categorical Treatment of Equality"

5:40 – 6:15 Gordon Plotkin, University of Edinburgh
"Some Models for Axiomatic Domain Theory"

6:30 – 8:00 *Reception*
Southeastern Architectural Archive
Howard–Tilton Library

MFPS XI

Thursday, March 30, 1995

All meetings take place in the Kendall Cram Room, unless otherwise noted.

8:00 – 8:45 *Breakfast rolls and coffee*

8:45 – 9:45 Ed Clarke, Carnegie–Mellon University, Invited Lecture:
"Model Checking and Symmetry"

9:45 – 10:20 Susan Older and Stephen Brookes, Carnegie–Mellon University,
"Full Abstraction for Strongly Fair Communicating Processes"

10:20 – 10:45 *Break*

10:45 – 11:20 Michael Mislove, Tulane University
"Denotational Models for Unbounded Nondeterminism"

11:20 – 11:55 Michel Schellekens, Carnegie–Mellon University
"The Smyth Completion: A Common Foundation for Denotational
Semantics and Complexity Analysis"

11:55 – 12:30 Zoltan E'sik and L. Berna'tsky, A. Jo'zsef University,
"Scott Induction and Equational Proofs"

12:30 – 2:00 *Lunch*

2:00 – 3:00 Andreas Blass, University of Michigan, Invited Lecture:
"Linear Logic and Dialogues"

3:00 – 3:35 Francois Lamarche, Imperial College
"Generalizing Coherent Domains and Hypercoherences"

3:35 – 3:55 *Break*

3:55 – 6:15 Special Session on Object Oriented Programming
Luca Cardelli, DEC and John Mitchell, Stanford University, Organizers

3:55 – 4:30 Krishna Kishore Dhara and Gary T. Leavens, Iowa State University
"Weak Behavioral Subtyping for Types With Mutable Objects"

4:30 – 5:05 Jonathan Eifrig, Scott Smith and Valery Trifonov, The Johns Hopkins University
"Type Inference for Recursively Constrained Types and its Application to OOP"

5:05 – 5:40 Cliff Jones, University of Manchester, TBA

5:40 – 6:15 Panel Discussion

8:30 – 9:30 Michael Mislove, Tulane University,
"Some thoughts on electronic publication."
Ramada – St. Charles Hotel

MFPS XI

Friday, March 31, 1995

All meetings take place in the Kendall Cram Room of the University Center, unless otherwise noted.

8:00 – 8:45 *Breakfast rolls and coffee*

8:45 – 9:45 Robin Milner, University of Cambridge, Invited Lecture:
"Action Calculi and Control Structures"

9:45 – 10:20 Philippa Gardner, University of Edinburgh
"A Name–free Account of Action Calculi"

10:20 – 10:45 *Break*

10:45 – 11:20 Ugo Montanari and Marco Pistore, University of Pisa,
"Concurrent Semantics for the pi–Calculus"

11:20 – 11:55 Alan Jeffrey, University of Sussex
"A Fully Abstract Semantics for a Nondeterministic Functional Language with Monadic Types"

11:55 – 12:30 Andrew D. Gordon, University of Cambridge
"Bisimilarity as a Theory of Functional Programming"

12:30 – 2:00 *Lunch*

2:00

Parallel Open Sessions

Session I

Open Session Talks
President's Room A
University Center

Session II

Free time for sightseeing
New Orleans

7:00 – 7:30 *Open bar,*
Hotel Intercontinental, 444 St. Charles Avenue

7:30 – 10:00 *Conference Dinner,*
Hotel Intercontinental, 444 St. Charles Avenue

MFPS XI

Saturday, April 1, 1995

All meetings take place in Lecture Hall 131 of the Business School, located across McAllister Drive from the University Center, unless otherwise noted.

8:00 – 8:45 *Breakfast rolls and coffee*

8:45 – 9:20 Robert Flagg, University of Southern Maine and Ralph Kopperman, CUNY "Fixed Points and Reflexive Domain Equations in Categories of Continuity Spaces"

9:20 – 9:55 D. N. Hoover, Odyssey Corporation "Maximal Limit Spaces, Powerspaces, and Scott Domains"

9:55 – 10:30 F. Alessi, P. Baldan, and G. Belle', University of Udine, and J. J. M. M. Rutten, CWI Amsterdam, "Solutions of Functorial and Non–functorial Metric Metric Domain Equations"

10:30 – 10:50 *Break*

10:50 – 11:25 Abbas Edelat, Imperial College "Domain Theory in Learning Processes"

11:25 – 12:00 Kay–Jeannette Nuessler, University of Essen "Universality and Powerdomains"

12:00 – 12:30 Achim Jung and Hermann Puhlmann, TH Darmstadt "Types, Logic and Semantics for Nested Databases"

12:30 – 2:00 *Lunch* Faculty Dining Room of the University Center

2:00 – 2:35 J. R. B. Cockett and D. A. Spooner, University of Calgary, "Categories for Synchrony and Asynchrony"

2:35 – 3:10 Bart Jacobs, CWI, Amsterdam "Subtypes and Bounded Quantification From a Fibred Perspective"

3:10 – 3:30 *Break*

3:30 – 4:30 John Reynolds, Carnegie–Mellon University, Invited Lecture: "Passivity and Linear Types"

End of Conference

MFPS XI Program
Open Session Talks

This session takes place in President's Room A of the University Center

2:00 – 2:30 Guo–Qiang Zhang, University of Georgia
"The Largest Cartesian Closed Category of Domains"

2:30 – 3:00 Michael Huth, Technische Hochschule Darmstadt:
"The Greatest Symmetric Monoidal Closed Category of Scott Domains"

3:00 – 3:30 Marta Kwiatkowska, University of Birmingham
"On Generalised Synchronisation Trees"

3:30 – 4:00 Frank Oles, IBM Research
"Topology, Lattice Theory and Knowledge Representation Languages"

4:00 – 4:15 *Break*

4:15 – 4:45 Peter Strain–Clarke, Open University
"Conway Games and Linear Logic"

4:45 – 5:15 Sergey Kotov, Kansas State University
"Logical Relations for Properties at Higher Types"

11:55 – 12:30 Vaughan Pratt, Stanford University
"Duality is a Red Herring for Stone Duality"

Abstracts

The Largest Cartesian Closed Category of Stable Domains
Guo–Qiang Zhang, University of Georgia

We show that dI–domains with stable maps form the largest cartesian closed category within Scott domains.

The Greatest Symmetric Monoidal Closed Category of Scott–domains
Michael Huth, Technische Hochschule Darmstadt, Germany

Linear Domains and Linear Maps [MFPS'93] form a symmetric monoidal closed category of Scott–domains, LIN, in the extensional order. We show that all symmetric monoidal closed categories of Scott–domains with linear maps as morphisms, ordered extensionally, are contained in LIN. The proof reduces to showing that a complete lattice L with algebraic function space [L --o L] of sup–maps is necessarily an algebraic linear FS–lattice.

On Generalised Synchronisation Trees
Marta Kwiatkowska, University of Birmingham

We consider Winskel's category of synchronisation trees and generalise them by adding "limit points" of a subset of infinite paths. A tree is a non–empty, prefix–closed set of finite strings labeled by elements of a synchronisation algebra. For a fixed synchronisation algebra L, L–trees form a category, in which semantic operations arise as categorical constructions: sum is a coproduct, while the synchronous and asynchronous parallel composition are restrictions of the product. In addition, the L–trees form an algebraic dcpo, with respect to which all the semantic operations are continuous. A generalised tree (abbrev. g–tree) is a pair consisting of a tree and a set of infinite strings denoting a subset of the infinite paths through the tree. Not all infinite paths have "limit points" associated with them. The sets of "limit points" can be thought of as environmental constraints (including fairness constraints). We obtain a category of generalised trees, in which the constructions on trees generalise to the corresponding categorical constructions on g–trees. We discuss two natural partial orders on g–trees, with respect to which the generalised trees form a dcpo, but fail to be algebraic. For the stronger order we obtain continuity of the semantic operations; in contrast, the (synchronous) parallel fails to be continuous wrt the weaker order (it is monotone). We use the category of g–trees to give denotational semantics to Milner's SCCS extended with the delay operators which agrees with Milner's operational semantics.

Topology, Lattice Theory, and Knowledge Representation Languages
Frank J. Oles, IBM Research

After giving a brief introduction to "KL–ONE type" knowledge representation languages and to the particular language K–REP, I will describe how a particular problem in constructing a medical lexicon has led me to reexamine the existing semantics of these languages. My thesis is that a given knowledge base has two mathematical aspects: we may think of it in terms of its models and we may think of it as a presentation of an algebra. On the model–theoretic side, I will advance the idea that the notion of a model of a knowledge base should not be simply set–theoretic, but should make use of topology. This involves coming up with a satisfactory definition of continuous relation that generalizes the definition of continuous function. In the course of doing so, some interesting adjunctions have been found. On the algebraic side, I will discuss how use can be made of the representation theory for distributive lattices in implementing these languages. Trying to establish a firm connection between the two aspects seems to require a generalization of the Birkhoff–Stone Representation Theorem for distributive lattices to what I call "concept algebras." This is work in progress, so expect some occasional conjectures where theorems ought to be.

Conway Games and Linear Logic
Peter Strain–Clark, Open University

We present a new categorical model of linear logic based on Conway games. The treatment is similar to the work of Abramsky et al. and we too incorporate the MIX rule. The

categorical structure of the model is symmetric monoidal, closed, with exponential co–monad. However the additives, whilst soundly modeled, do not correspond to categorical product and coproduct

Logical Relations for Properties at Higher Types
Sergey Kotov

A technique of mechanical derivation of logical relations for studying higher–order properties of PCF–like languages and their models is presented. It makes possible a uniform general construction of proofs for different evaluation styles and models. The approach is applied to the property of complete adequacy. The relationship of logical relations to a different reducibility technique is obtained.

Duality is a Red Herring for Stone's Theorem
Vaughan Pratt, Stanford University

I define a variant of the usual notion of topological space where the opens are only required to be closed under finite unions and finite intersections, and prove that the category C of compact totally separated such and their continuous maps defined as for topological spaces is isomorphic to the category C' of Stone spaces. One advantage of C is that its duality to Bool is immediate, revealing the main content of Stone's theorem to be the above covariant isomorphism C~C', whence the title.

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The Eleventh Annual Conference on the Mathematical Foundations of Programming Semantics. and featured invited addresses by six international researchers, two special sessions and twenty-four talks selected from papers submitted by researchers from all over the world. The conference attracted 77 participants from 9 countries, and the ONR grant helped provide support for the six invited speakers, for the participants in the special session, and for women and minority participants who participated in the meeting. The conference published its *Proceedings* as the first volume of the new series *Electronic Notes in Theoretical Computer Science*, which is published electronically on the World Wide Web using the facilities and under the auspices of Elsevier Science B.V. This *Proceedings* can be accessed via the URL: http://www.elsevier.nl/locate/entcs/volume1.html. A further *Proceedings* consisting of expanded, journal-length papers selected from the papers presented at the meeting is in preparation. This will appear on a special issue of the journal *Theoretical Computer Science*. The funding was used to support the invited speakers t the meeting, to help support participants in the two special sessions, and to underwrite general conference support costs including support of graduate students, women and members of minority groups.

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